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Investigation and Analysis of Present Situation and Future Prospect of Information and Communication Technology to Develop Agriculture in Nepal

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INVESTIGATION AND ANALYSIS OF PRESENT SITUATION AND FUTURE PROSPECT OF INFORMATION AND COMMUNICATION TECHNOLOGY TO DEVELOP AGRICULTURE IN NEPAL

ICT can help the advancement of Agriculture in many ways. The traditional way of practicing agriculture is no longer sufficient for the growing world. Therefore, the necessity of digitalizing all information related to agriculture is vital so that it could be accessible to all of them who would like to acquire it.

Mobile communications and Internet have gradually reached most areas of Nepal. Therefore, the users of such technology have also been undoubtedly increasing in recent years. By exploiting such technologies, every farmer could benefit e.g. establishing a helpline to assist with the problem of farmers, developing websites in different languages.

Mapping agricultural resources with Geographical Information System and Remote Sensing Technology and use of mass media in agriculture such as television and radio are equally important technologies. However, using these technologies is very limited in the country.

The concept of E-Agriculture is emerging rapidly in recent year. The main concept of E-Agriculture is to exchange information, ideas and resources among people, research centers, universities, governments, Non-governmental organizations, private sector etc. from all around the world and using ICT and its ultimate goal is sustainable agriculture and rural development. The E-Agriculture is very suitable for Nepalese context.

So, the roles of ICT could be as a catalyst to connect people from all over the world. IT personnel could help marginalized people to join online community to share and gain knowledge, new ideas, and technologies. Moreover, IT technicians can also build user friendly application so that everyone can use it easily.

KEYWORDS:

Internet, Mobile Communication, Geographical Information System, Remote Sensing, Mass Communication, E-Agriculture

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LIST OF ABBREVIATIONS (OR) SYMBOLS

2D	Two Dimensional
3D	Three Dimensional
ACORAB	Association of Community Radio Broadcasters
AICC	Agriculture Information and Communication Center
AM	Ante Meridiem
ATM	Automated Teller Machine
BBC	British Broadcasting Corporation
BST	Base Transceiver Station
CAN	Computer Association Nepal
CBS	Center Bureau of Statistics
CNN	Cable News Network
DHM	Department of Hydrology and Meteorology
ESPN	Entertainment and Sports Programming Network
ETV	Environment Television Channel
FAO	Food and Agriculture Organization
FM	Frequency Modulation
GDP	Gross Domestic Products
GHz	Giga Hertz
GIS	Geographical Information System
GLCI	The Great Lakes Cassava Initiative
GMPCS	Global Mobile personal Communications by Satellite
GPS	Global Positioning System
GSM	Global System for Mobile communication
GTS	Global Telecommunication System
IBM	International Business Machines
ICIMOD	International Center for Integrated Mountain Development
ICT	Information Communication Technology
ISM	Industrial, Scientific and Medical
ISP	Internet Service Provider

IT	Information Technology
JTA	Junior Technical Assistant
MENRIS	Mountain Environment and Natural Resources' Information System
MIS-NTA	Management Information System- Nepal Telecommunication Authority
MOAC	Ministry of Agriculture Cooperatives
MOAF	Ministry of Agriculture and Forestry
NARC	National Agriculture Research Council
NARDF	Nepal Agriculture Research and Development Fond
NCC	National Computer Center
NTA	Nepal Tele-communication Authority
NTC	Nepal Telecommunication
NTV	Nepal Television
PAN	Practical Action Nepal
PDF	Portable document Format
PM	Post Meridiem
Pvt. Ltd.	Private Limited
RONAST	Royal Nepal Academy of Science and Technology
RS	Remote Sensing
SADIS	Satellite Distribution Information System
SMS	Short Messaging System
TV	Television
UNCTAD	United Nations conference on Trade and Development
URL	Uniform Resource Locator
VSAT	Very Small Aperture Terminal
WLL	Wireless Local Loop

1 INTRODUCTION

1.1 ICT in General

Information and Communication Technologies or ICT is a science that deals with digital technology that has been used in different devices. Digital Technology has enabled the flow of digital information all around the world via internet connection with computers and telecommunications. The application of ICT has been spreading to almost all the fields. “Information and communication technologies or ICT is about digital information passing between devices. The most prolific example is the Internet, a worldwide network of computers linked together by telephone lines. There are, however, other examples like mobile phones, interactive television and personal organizers” (Cronin, 1994). The traditional concept of ICT was different from its modern definition as its area is broadening. Traditionally, ICT was considered as the use of computer at home and office only for data creating, storage and transfer via internet etc. However, there are many areas that are considering widening its field. Therefore, the broad sense includes the way of using ICT in other field such as business, agriculture, tourism, transportation, forestry etc. Since the use of ICT is broadening, there is a need for management of data so that it can be understandable as well as data capture, verification and storage. This could help to build an understanding of the importance of information data which is very useful for efficient work for any field related to ICT.

There are already several usages of ICT in everyday life. In Education, ICT is used as follows:

Useful information can be retrieved from the Internet.

E-book and e-magazine can be read from the Internet.

Students can check their class timetables from the Internet

Libraries are automatically automated to manage books on the shelf by using ICT etc.

ICT can also be considered more useful for personal usages in daily life such as:

Using email, social network sites etc.

Watching television

Making phone call and sending SMS etc.

In banking, ICT has been used for bank management. For instance,

Using net banking for fund transfers, balance checking, bill payments etc.

Withdrawing money from ATMs

Online shopping

The Industry sector also adopts ICT to improve work efficiency in factories. For example,

Various factories use automated packaging machine to pack their products.

Automobile companies use robotic and artificial intelligence to manufacture automobiles and different kind of vehicles.

ICT is implemented for various commercial purposes as well. For instance,
Using electronic media such as TV and radio for advertising purposes

Using electronic hoarding board in high traffic areas in the town

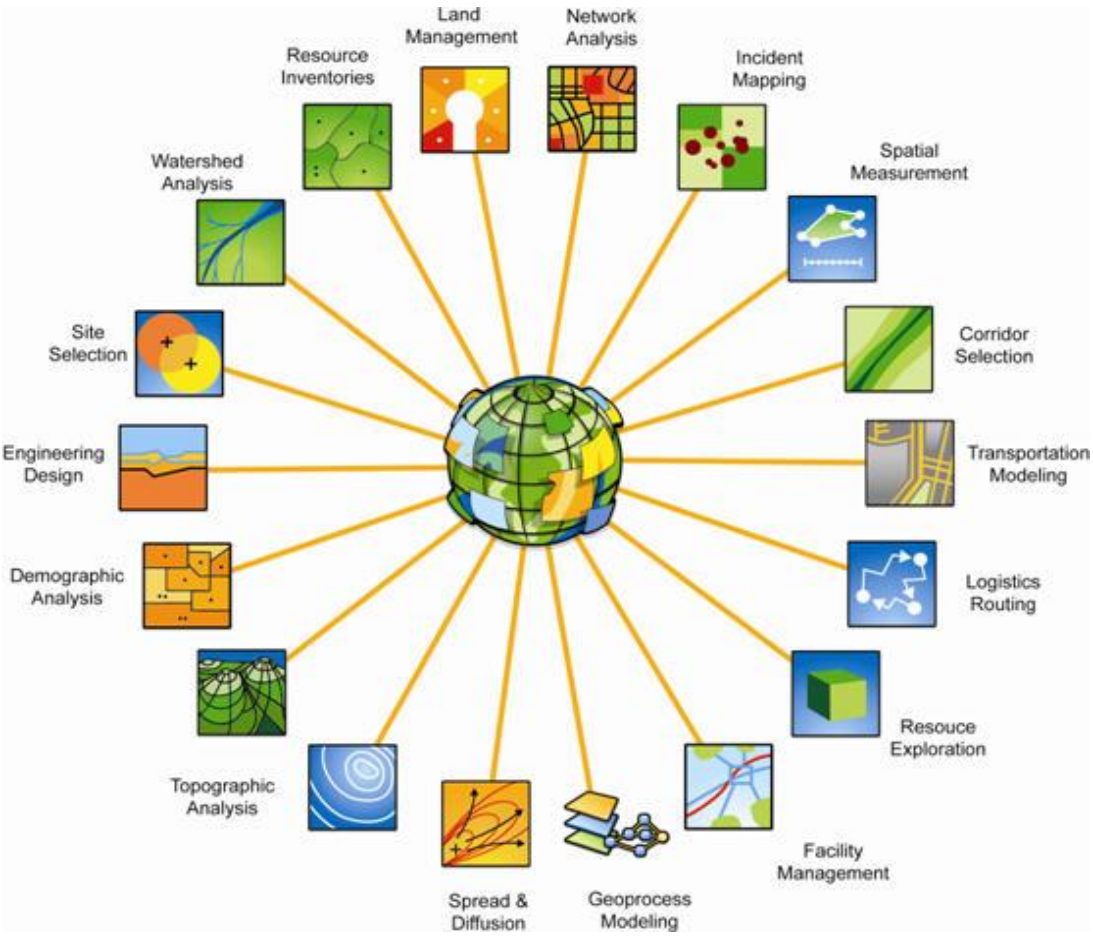
Advertising via text message or phone call or email

Internet business or e-commerce

Buying fuel from gas stations

1.2 Geographical Information System (GIS)

GIS is a computer-based software application system which is designed in such a way that the data information can be captured, managed, interpreted and visualized in different ways. It can demonstrate clear understanding of the specified geographic location by means of figures, charts, graphs, reports etc. GIS is an extraordinary technological achievement which provides human beings with an innovative way to watch the earth surface. There are many applications of GIS. Some of these applications are briefly described in following paragraphs.



Picture 1. Various Applications of GIS (Abukhater, 2011)

The geographic condition of the earth is altered slowly through the course of time. Map change is an application of GIS which helps to predict the future conditions. It can be applied for both locally, regionally and globally. This is a

very important tool for taking measures against predicted upcoming conditions in the future. For instance, the rainfall pattern that might occur in the future can be predicted. The time and path of hurricane that might occur in the future may also be predicted.

GIS is the best application to find buildings that are located in the surroundings, for example, police station, gas station, school, shopping complex, municipality building, and world trade Center etc. GIS is helpful to track the population density, animal density, tree density etc. Density mapping are taken by using a uniform areal unit which the clear distribution of features that are available in that area. Similarly, mapping number of inhabitants in given location is possible to map the criteria to implement the action with GIS. For example, a government can evaluate whether or not every 5000 citizens have access to one health center in an area. If not, government might start establishing a new health center.

Thus, GIS offers benefits to nearly all sectors. First, many industries are following GIS nowadays. Cost savings and increasing work efficiency are some of the reasons behind it. Second, it offers management of the surrounding activities geographically. It is a very useful tool to which informs about what might happen and what is happening now in a particular area. Third, people can find out and implement a proper action plan at right time and place. Fourth, as GIS is communicative tool; people from almost all sectors can benefit by understanding it. For instance, in a multicultural society, a businessman can open an Asian food shop in the area where more Asian people are living. The farmers, who would like to lease a piece of land, GIS offers information about water sources and transportation facilities nearby. Finally, GIS maintains good record-keeping which benefits all disciplines.

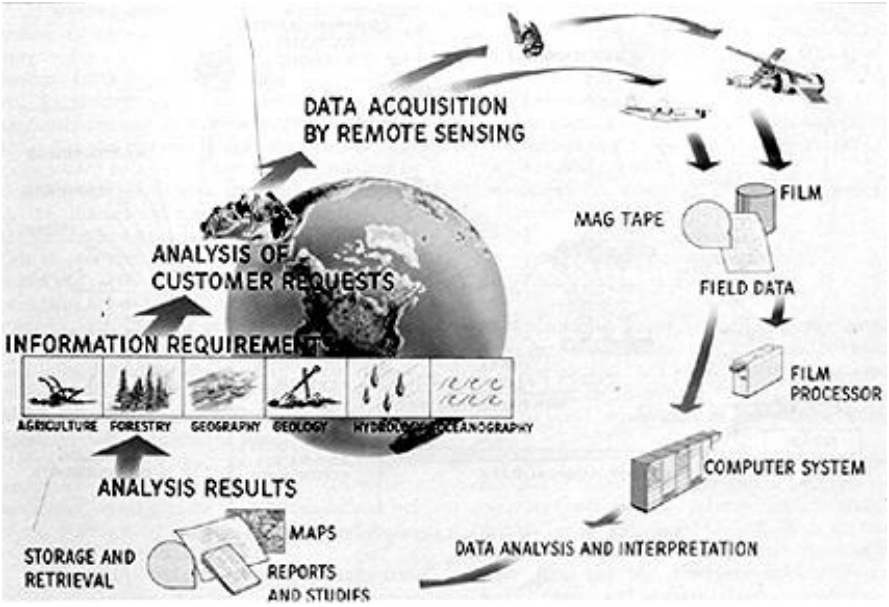
1.3 Remote Sensing (RS)

Remote sensing is a technology that enables us to acquire information about objects which are in contact physically or far away from the observer. In general understanding, there are five different senses, namely, sight, taste, touch,

hearing and smell. For some of them, it is necessary to have direct contact to know the information about the object which is under observation, e.g., tasting and touching. On the other hand, there is no need of direct contact for hearing and seeing. Our organs, such as ears and eyes are capable of performing remote sensing of the surrounding objects. However, it is not always possible to acquire detailed information of the objects which are located in different locations. Because of this constraint, people have developed instruments for remote sensing to retrieve full of information of objects which are far away and located in inaccessible places. Those instruments can retrieve and collect information and save it for further processing.

The remote sensing process uses the electromagnetic radiations coming from energy source, such as sunlight or other illuminating sources. Since the energy passes through from source to the destination and later from destination to the sensor, its interaction with the atmosphere may take place two times. When energy reaches to destination objects, it interacts with destination objects. The size of interaction is decided by properties of both energy and object. The emitted energy forms the target object which is recorded by the sensor in the form of electromagnetic radiation. Then, the recorded energy is transmitted in electronic form to the receiving and processing station to retrieve clear images of the object which are analyzed and interpreted to make authentic and useful information for further uses for different purposes. The Image analyses are made with different techniques which depend on the types of information that are needed for different purposes. However, segmentation and classification algorithm are more common techniques which are used for most of the purposes (Natural Resources, Canada).

The remote sensing technique is usually used with aircrafts, satellites and balloons. RS has enabled monitoring, mapping, observing, studying wide areas of earth surface such as vegetation, environment, seabed, ocean surface etc.



Picture 2. Typical Remote Sensing System (Short, 2011)

There are several benefits of using remote sensing technology. It is a very useful tool to study the different characteristics of earth surface. The understanding of spatial relations between those features helps to describe the required features. RS is more useful when it is needed to study inaccessible, dangerous and difficult-to-reach places such as glaciers, space, underwater location etc. RS is more efficient and time-saving when it is needed to study large area. The wide range of benefits of RS has been applied in many different sectors such as space study, environmental study, biodiversity, glacier, agriculture, forestry etc.

1.4 Global Positioning System (GPS)

According to the Cambridge online dictionary, GPS is a system that can show the exact position of a person or an object by using signals from satellites. Therefore, satellites are the objects which play a great role for signal transmission from space to earth. GPS is very useful in today's world for finding the exact location of any objects, people and their velocity if they are flying or moving. This system can provide such information anytime, anywhere and in any kind of weather condition where the system is available.

GPS was first developed for military purposes by the government of the United States. However, it was made available for all people later on. As it is a satellite based navigation system, there are 24 satellites installed on earth orbit. Those satellites move around the earth in their own orbits twice in a day. When these signals are received in a GPS receiver, it calculates the information signals with the triangulation method to find the accurate location of objects. The GPS receivers must be locked on the signals from at least three satellites to calculate two dimensional (2D) positions of objects with the information of longitude and latitude. Likewise, the receivers, which are locked on with signals from four or more than four satellites, can calculate the three dimensional (3D) position of objects which means that the receivers also calculate altitude along with longitude and latitude. In addition, the receivers also calculate its distance from the satellite which is obtained from calculating the time duration of transmission of signal from satellite and the time of receiving the signal by the receiver. Thus, the user position is determined with the help of distance measurement of the signals using few more satellites which are finally displayed in units in electronic devices as a map (http://www8.garmin.com/aboutGPS/).

There are several benefits of GPS. GPS is a powerful technology which offers the accurate information about the route, distance and time required for travelling and reaching a destination. GPS is useful a tool to find the right direction to the unfamiliar destination. For example, people have more probabilities to get lost when people are hiking, trekking, camping and marine fishing. In this situation, GPS can help to find the way back home. Moreover, Courier Business and Taxi business benefit from GPS. It helps to track the delivery status by tracking vehicles for courier business. Similarly, in the taxi business, the current locations of taxis are tracked and the taxi which is the closes to the calling customer is informed to go to pick the customer. The GPS operators from main office of taxi business are the one who give the information to the taxi driver (http://benefitof.net/benefits-of-gps/).

2 OBJECTIVES, SCOPE AND LIMITATIONS

The main objective of this study is to find the evidences of ICT applications being used in agriculture in different countries. Based on those uses, there are still many actions/improvements that might be carried out in Nepalese agriculture. Another objective of this study is to investigate the present scenario and growth trends of ICT in Nepal. With existing ICT, the agriculture could benefit. Therefore, analyzing the technologies that can promote agriculture in Nepal is final objectives of this study. Thus, this study mainly emphasizes the necessity of collaboration between ICT and agriculture. On the other hand, this study does not include the activities description of private organizations in details, since the study was made without reaching them face-to-face. Even though attempts were made to retrieve information through email, the responses were not received. This study does not also cover behavioral changes of farmers with the introduction of ICT. However, the recommendation section of this thesis emphasizes the further potential area to be covered. Furthermore, the user friendly application development to facilitate Nepalese farmers could be another area for further study in the area of ICT in agriculture.

3 HISTORY OF ICT IN NEPAL

3.1 Computer and Internet History

In 1971, the government of Nepal first introduced information technology for the national population census. The national Computer Center (NCC) was established in 1974 to facilitate computer skills and train citizens. Moreover, NCC developed useful software for government agencies, such as examination software to publish results from Tribhuvan University etc. In the early 1980s, IBM-compatible personal computers and then the first Apple computers were introduced in Nepal.

There was rapid growth of private IT companies in Kathmandu valley by mid 1980s. However, there was still limited significant progress in this field. In 1982, one of the private companies, which were the first US-Nepal joint venture, Data System International Pvt. Ltd, initiated to work on IT.

After 1990, there was a significant development of ICT in Nepal because of liberal environment which was established by the popular movement of 1990. The commercial email and internet services were initiated in 1992 by the collaboration between Mercantile Communication Pvt. Ltd. and Royal Nepal Academy of Science and Technology (RONAST). In 1995, Mercantile Communication Pvt. Ltd was registered officially as first ever Internet Service Provider (ISP) in Nepal.

The private sector started rapid activity after 1996 by establishing its own training institute and also developed Nepali fonts. Very-Small-Aperture Terminal (VSAT) was introduced in 1997 under the legislation of the 1997 Telecommunication Act which led to the growth of ISP and the price of internet service was reduced significantly. In 1998, government of Nepal decided to dissolve NCC which was run by government and to promote privatization. However, government of Nepal had established the Nepal Telecommunication Authority (NTA) under the Ministry of Information and Communication.

The international domain ".np" was settled with jurisdiction of Nepal in 2000. There were some institutional agreements, such as National Information

Technology which was established to implement ICT-related tasks under the IT policy 2000. The government of Nepal regulated and de-licensed the ISM Band wireless frequencies (2.4 GHz and 5.8 GHz) in 2007 which opened more opportunities for the extension of wireless network in the rural and urban areas. The government of Nepal released the Science and Technology Policy -2005 and Electronic Transaction Ordinance (Cyber law) - 2005. The Telecommunication Regulation in 1997 has opened more opportunities for telephone operators as well as ISPs. Until 15 November 2010, there have been more than 47 ISPs, 3 fixed telephone service providers, 2 GSM cellular Mobile service providers, 109 VSAT users, 8 rural VSAT users, and 6 rural Internet service providers (NTA, 2010). Until 2012, all major cities and district headquarters have internet services provided by a local ISP and also have 3G and 2G mobile network provided by Nepal Telecom and N-cell which is operating in Nepal with the collaboration of TeliaSonera (Nepal Wireless, 2012 & Nepal Telecom, 2012).

3.2 History of Telecommunication

The first telephone lines were established in the capital city Kathmandu in 1913 and there were open wire trunk lines from Kathmandu to Raxaul, a city in India in 1914. In 1935, 25 lines of automatic exchange were installed in the Royal palace in Kathmandu. The open wire trunk line was further extended to Dhankuta, a city in eastern Nepal in 1936. In 1950, the following were established: telegram service, high frequency radio system AM (Amplitude modulation) and 100 lines cell broadcast telephone exchange in Kathmandu. One more open trunk line from Kathmandu to Palpa, a central district of Nepal was installed.

Telephone lines were first ever distributed to the general public in 1955. In 1964 the International Telecommunications Service was launched in India and Pakistan by using high frequency radio. About 1000 lines of Automatic exchange were installed for the first time for the general public in Kathmandu.

In 1972, the Telex service was introduced to connect domestic long distance. This was the beginning of a new era of telecommunication history in Nepal. The

first station of earth satellite was installed in 1982. With World Bank assistance, Nepal achieved major improvements in telecommunication sector after 1995. Public Switched Telecommunications Network achieved considerable success during the Fifth Phase Telecom Project (1992 to 1997) of Nepal Telecom, the main authority of Telecommunication of Nepal.

There were about 300 lines of local exchange line which were established in Kathmandu in 1995. Other areas of country were still almost completely disconnected. However, there were some connections with short-wave radio. In 1999, with the continuing growth of this sector, Nepal achieved remarkable development in this field with one line per 100 households. However, it was still far below relatively. Nepal Telecom introduced the first GSM phone service only in major cities in the country in spring 1999. In the same year, one of the private Telecom Company named United Telecom LTD started Wireless Local Loop (WLL) based telecommunication services only in major cities.

Telecommunication Policy 2004 was introduced to enable accessible and reliable services. Another private Telecommunication company called Spice Nepal PVT. LTD. also introduced GSM phone service only in major cities since autumn 2005. Following the introduction of WLL and GSM mobile services, the numbers of subscribers were increased significantly after 2007. Both government authorities and private companies were more active to expand their service and subscribers. As a result, the number of subscribers reached approximately 8 percent of the total population of Nepal. As subscribers increased, both NTC and Spice Nepal started to also install their BTS (Base Transceiver Station) in remote area of the country which leads to 36 percent of population benefiting from mobile communication. This achievement was about 16 percent more than previously planned in the beginning. By the end of 2011, the mobile telephone subscribers rapidly reached 45 percent. Now, not surprisingly more than 50 percent of the population enjoys this service. There are still high demands for service in different part of the country, therefore telecommunication reformation is well under way (Nepal Telecom, 2012).

4 CONCEPT OF E- AGRICULTURE

“E-Agriculture is a relatively new term and its scope is expected to change and evolve as understanding of the area grows. For now, e-Agriculture is seen as an emerging field focusing on the enhancement of agriculture and rural development through improved information and communication processes. More specifically, e-Agriculture involves the conceptualization, design, development, evaluation and application of innovative ways to use ICT in the rural domain, with a primary focus on agriculture. Standards, norms, methodologies, tools, development of individual and institutional capacities, and policy support are all key components of e-Agriculture” (FAO, 2007). The term “E- Agriculture” is first emerged after World Summit on the Information Society in 2003 and 2005 and later when Food and Agriculture Organization (FAO) began their survey in 2006.The survey result showed that majority of people described this term as exchanging information through the electronic media so that rural community can also access information which could benefit the rural community through the improvement of agricultural practice. Therefore, the information dissemination in rural communities is a major key for the improvement of rural livelihood through the implementation of ICT in agriculture.

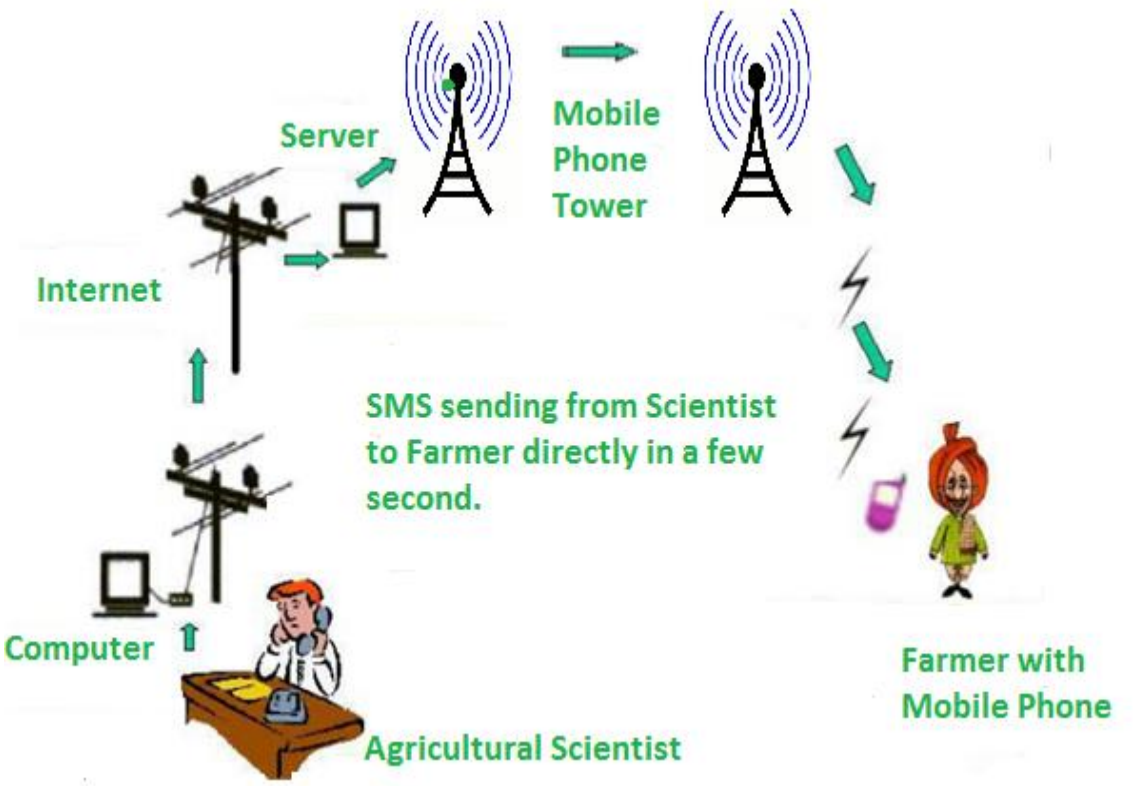
There are still many farmers in rural areas around the world who do not have access to proper innovative information related to agriculture and they are still forced to practice agriculture in their own traditional way. In this sense, the worldwide community through electronic media such as internet connected computer, mobile phone, television etc. are essential to exchange and retrieve information within time. These days there are few online portals that have been developed. However, this is not still understandable by all people around the world since it has been built in just few languages. One of the online communities of E- agriculture is “e-agriculture.com”, which has approximately 8000 members from 160 nations from all over the world. This is the best example of E- Agriculture community. More members are expected to join this community in the near future.

The main goals of E- Agriculture is to equip rural people with more agricultural information in the fastest way such as using electronic media and finally, farmers could harvest more yield. Appendix 3 ‘The Platform Architecture of E-Agriculture in China’ (Huawei Technologies, 2009), shows that Huawei technologies have established agricultural hotspots in many rural areas. Farmers can access information about preventive pest control measures, prices of agricultural materials and weather forecast. This system has been providing very good service to rural farmers. Since E-Agriculture is a collective task, thus, more disciplinary groups should come together to make this task successful. Those disciplinary experts could be agriculturists, IT personnel, government representatives, farmers, research study groups, social workers etc.

5 ICT APPLICATIONS FOR AGRICULTURE

5.1 Mobile phone Application in Agriculture

The mobile phone has been used in agriculture directly or indirectly all over the world. Developed countries have already adopted this technology a long time ago and this trend is continuously growing in developing nations in recent decades. The mobile phone is very useful for acquiring market information of agricultural products and inputs and accessing agricultural experts to solve agriculture-related problems such as plant and animal diseases, pest and insects etc. In addition, farmers can also enter different kinds of data, information and important dates in their mobile phone. It is also possible to take pictures of important events, crop fields etc. with mobile phone for demonstration purposes. Moreover, the general calculation of agriculture finance can be done with mobile phone. Therefore, there are several benefits in using mobile phones in agriculture. The mobile phone has been the most common device everywhere in the world. For this reason, farmers can exploit many benefits from it. Since, the local weather is the most important factor in agriculture, farmers can receive timely weather forecast for specific areas from their mobile phone devices. This innovation seems very useful to apply proper agricultural practices in the field according to the local weather condition. Such practices could be the amount of irrigation, harvesting time etc.



Picture 3. Computer to SMS Broadcast Service in India (Charyulu, 2009)

The farmers, who have up-to-date information about market situation, may seek the cheapest possible market. The up-to-date information can be received from various traders in the form of SMS, email, phone call in mobile phone instantly. In some instances, access to mobile phones has been associated with increased agricultural income. A World Bank study conducted in the Philippines found strong evidence that purchasing a mobile phone is associated with higher growth rates of incomes, in the range of 11–17 percent, as measured through consumption behavior (Labonne and Chase 2009).

There are several examples demonstrating that mobile phones are transforming the agricultural sector rapidly. Chokshi (2010) mentions that experts in India have developed the electric water pump called “Nano Ganesh” which is fully controlled with mobile phone to irrigate the farming land. This transformation has saved a huge amount of time. This invention was the winner of global innovation contest in the year 2009. The contest was run by the mobile phone giant Nokia Corporation Pvt. Ltd. He also states that Tata, a multinational

conglomerate, allows farmers to send photos of diseased crops to experts directly from their phones. Another company, ITC Limited, set up "Traders Net," a virtual commodity exchange that connects producers and wholesale purchasers of coffee.

Esoko (2012) states that in many African countries the mobile phone is one of the most accessible tools farmers are using to obtain agricultural insurance products. Farmers can make registration as well as payouts of the new insurance policy with their mobile devices. This kind of insurance system is gaining popularity very rapidly. It is expected that farmers will increase their farm productivity by using insured improved seeds and fertilizer. Esoko is a good example of market information services of agricultural goods. In this system, people who have registered in this network will get information about amount and price of agricultural goods via mobile phone. Esoko is currently operated in 15 African countries which are Ghana, Nigeria, Swaziland, Burundi, Zambia, Zimbabwe, Sudan, Ivory Coast, Madagascar, Rwanda, Kenya, Mozambique, Malawi, Tanzania and Uganda. According to Esoko Ghana Ltd., they are currently providing the following services:

- Profiles (GIS, households, cropping etc.)
- Automatic SMS Alerts (prices, offers, weather)
- Bulk SMS Push (advisories, notification, procurement)
- SMS Polling (track field data/activities)
- Stock and Flow (track inventory/volumes)
- Easy Upload (SMS, Web, Java, Android)
- GIS & Maps
- Full data privacy and secure hosting

Similarly, the mobile phone operator of Bangladesh called Banglalink has established Agricultural Information Services Center providing technical information related to agriculture to the farmers. In this system, farmers can ask about agriculture-related problem by dialing 7676 and agricultural experts give back suggestions and solutions to the farmers.

In large scale agricultural practices, mobile phone has played a great role in advertising the need for extra labourers for different stages of agricultural activities. The job seekers can simply join the portal created by job center and they will be informed when the jobs are available. These kinds of services save the cost of transportation and valuable time as well. The best example of this kind of services is already started by a group called BabaJob in India.

To sum up the benefits of mobile phone in Agriculture, there might be even stronger role in the coming years. With the Android platform, IOS platform and windows OS, more users will be attracted to have phones which are very user friendly. Touch screens has made phones very easy to use. Many tasks which would only possible to do with internet connected computer traditionally, are also possible to do with a handset like smart mobile phone nowadays.

5.2 Use of computers and Internet in Agriculture

Using computers and internet is more efficient for any sector. In the agricultural sector, computers are used for many tasks. Thus, computers are more common in agriculture in developed countries whereas, there are still very few farmers who are using computers in developing countries. However, the users are growing day by day. Therefore, the scope of computers is still very high in those areas.

Picture 4. Using Laptop to enter data (Walsh, 2010)

Keeping agricultural finance records is a very important task in large scale agricultural activities. Thus, the computer is a necessary tool for keeping those

records. Keeping records with pen and paper is very time consuming and it is not so safe, therefore, computers have made such tasks very easier and less time consuming to keep safe as well as easy to calculate with just pressing the buttons. The agricultural finance includes many records such as the amount of inputs, income records, expenditures records, tax records, invoice records etc. Moreover, agricultural researchers are using computers for keeping data of their research activities such as the day of seeding, the length of seedling at certain stage of plant growth, day of flowering, day of fruiting, day of fertilizer application, day of harvesting etc. Those data are very useful for future reference.

In addition, the pictures and videos which are taken from the field can be saved in the computer. Those pictures and videos are very useful for demonstration as well as for diagnosing plant and animal diseases.

The other advantages of computers are finding new information related to agricultural activities from internet connected computers. These days, there are many online portals, social networking sites and web pages related to agricultural information which can bring farmers from all around the world in one place and they can exchange their idea and technical know-how related to agriculture. Thus, most of the problems of the field can be solved with the help of people from all around the world.

The farmers use computers and internet to know the market situation of agricultural input and products. Farmers can find the contact information of agricultural input suppliers and can send email to order the inputs. Farmers put their information about the products they want to sell so that online visitors can find this information and contact the farmers if they need those products.

The weather conditions are the most important factor in agriculture. Agricultural activities are planned according to local weather conditions. Therefore, it is always better to keep an eye on the weather forecast. It is not difficult at all to know the weather forecast these days. That information is easily found from

internet connected computer. The weather conditions includes rainfall, humidity, wind speed, temperature etc.

5.3 Use of computerized equipment

In modern agriculture, computers have their own place in every phase of agricultural practices. From the sowing seed or seedlings stage, harvesting, processing and to the market, the computers and internet have played a great role for better work efficiency. The current trend shows that the youth are reluctant to work in farmland and this has led to shortage of labor in this field especially in developing countries. Thus, the use of computerized machineries and other related technologies would be the best solution to solve the problem of lack of labors.

Picture 5. Using ICT in Greenhouse (The Canadian Encyclopedia, 2012)

Computerized equipment in agriculture has many uses such as tractors for ploughing fields, sprayers for fertilizer application and also for insecticides and pesticides application, planters for seed sowing, sprinklers for irrigation and harvesters for harvesting crops. Likewise, the greenhouse technologies are fully customized with computers for amount of light, temperature and humidity required by the crop plants. Moreover, the traditional way of milking with hand has been shifted to robotic milking machine nowadays. Similarly, there is no

need to dry the harvested grains under sunlight. There has been invented a grain drying machine which is much more time-saving and also efficient to use.

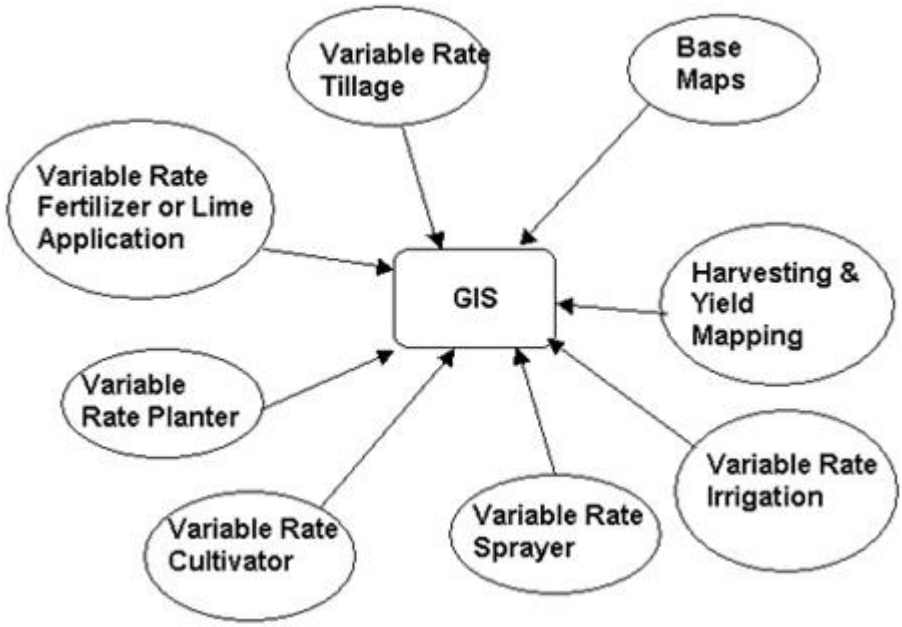
Picture 6. A robotic milking machine (Kardashian, 2009)

5.4 Use of GIS and RS in Agriculture

The terms GIS and RS are usually combined. The understanding GIS includes all types of earth properties such as elevation of land, weather trends, vegetation patterns, irrigation sources, soil type, soil moisture, severity of insects and pests etc. This information is retrieved from different sources and technologies. Therefore, RS is one of the technologies that retrieve data information. That information is converted into digital form which is integrated into GIS software.

For agriculture, the final agro-ecological maps consist of a combination of administrative map, climatic map, soil map, topographic map, land-use map and productivity map. This information is very useful to plan the agricultural activities in a specified location based on the clear views about surrounding environment

and factors that affect the agricultural productivity. Such information can be obtained from GIS software. GIS software has made the things much easier for agriculture. This software is used in different phases of agricultural activities. The integration of RS to GIS is very important for agricultural modeling. Since RS is a source of information of GIS, both have the same level of usefulness which is mentioned below.



Picture 7. Precision farming overview (GIS Development, 2006)

- By knowing the information of compactness of soil with the help of this software, farmers apply the right amount of tillage on their field which helps to save the cost of unnecessary excessive amount of tillage.
- GIS is very a useful application for identifying the exact location of water resources as well as for proper allocation of irrigation system throughout the agricultural field.
- GIS is used for selection of proper location for placing livestock or crops in the field.
- The amount of irrigation needed by plants is decided by the soil moisture content in the soil which is obtained with the help of GIS and RS.
- The amount of fertilizers or nutrients needed by plants is applied on the basis of soil nutrient contents in soil which are mapped with the help of RS and GIS software.

- Mapping of severity of insects, pest and diseases help to decide the control measure that are to be applied.
- Mapping of weather trends such as temperature, rainfall, wind velocity of the area obtained from GIS software which help to decide to grow the suitable crops for such weather condition.
- GIS and RS technology is used to estimate crop yield production
- GIS is used to categorize the land productivity. For instance, which areas are more productive and which area is less.
- Apart from above mentioned uses, the GIS software technology is used for selection of land for crop planting, crop rotation, companion crop and harvesting purposes.
- In large scale, RS is useful for survey and research purposes. Therefore, there is no need of visiting plot to plot every day.
- RS is a useful and efficient tool for crop management and agribusiness

5.5 Use of Mass Media in Agriculture

Mass media, such as TV and Radio, are also effective tools especially for rural communities. Disseminating scientific information related to agriculture to farmers is one of the main objectives of using mass media in agriculture. Nazari and Hasbullah (2010) reported that mass media offer effective channels for communicating agricultural messages which can increase knowledge and influence the behavior of intended audience. Rural farmers are usually illiterate especially in developing countries. Therefore, people who cannot read and write benefit from TV and Radio frequencies. They can listen to and watch scheduled agricultural related programs. These days, radio and TV channels are broadcasting agricultural programs in specific languages as well so that farmer target groups can understand these programs. “Participatory communication techniques can support agricultural extension efforts especially using local languages and rural radio and television to communicate directly with farmers and listeners’ groups” (Parvizian *et al.,* 2011).

5.6 Installation of Agro-Meteorological Station

Meteorological information is a vital component of agricultural model operations. Agricultural productivity is highly based on the local weather condition. Predictions of outbreak of plant diseases, insect and pest are made with the help of local weather condition. Therefore, a reliable meteorological station is most essential to successful agricultural practices.

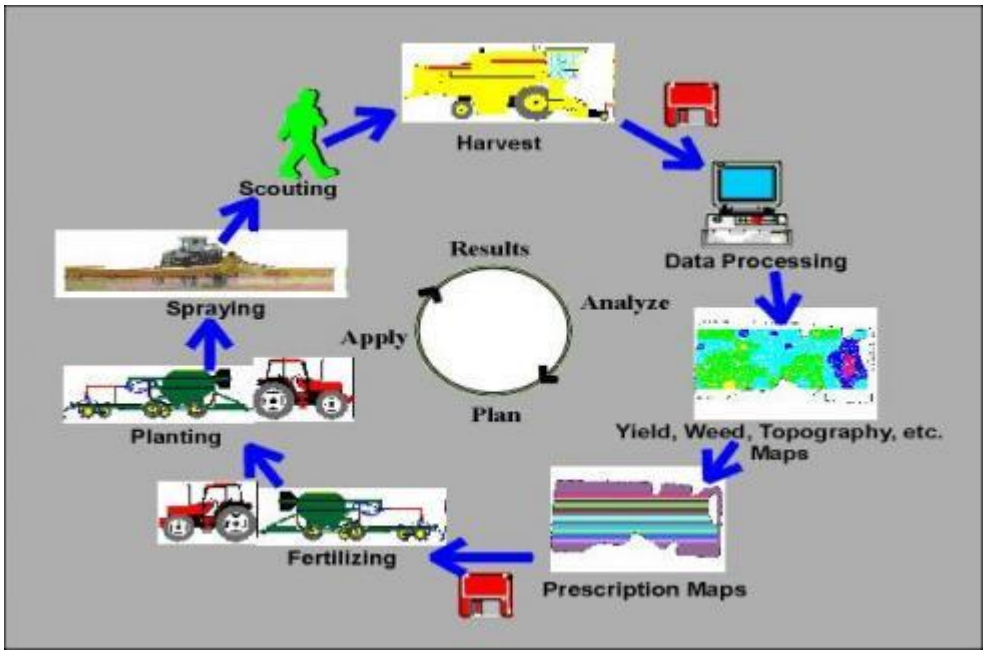
Picture 8. Complete automatic weather station (Delta- T Devices, 2012)

There are different kinds of computerized meteorological stations which can measure different atmospheric parameters such as precipitation, direct sunlight, diffused sunlight, air temperature, soil temperature, humidity, soil moisture, evaporation, wind speed and direction etc. This kind of station is collectively called agro-meteorological station. The information which is received from an agro-meteorological station is very helpful to apply to agriculture applications and operations at the right time. This kind of operation ultimately affects the final output of crop yield. These days there have been developed more specific and automated and computerized meteorological stations which are already in operation in developed countries but are coming in developing in the near future.

5.7 GPS in Agriculture

GPS is becoming highly innovative and efficient in the agricultural sector. There are many agricultural operations are performed with GPS-equipped equipment such as crop monitoring, soil sampling, harvesting, fertilizer application, cultivating, yield monitoring, livestock tracking, etc.

A tractor is one of the most used agricultural machinery in the world. The GPS-equipped tractor is becoming more popular and replacing the traditional tractor gradually. This innovative tractor can perform many agricultural operations such as cultivating, harvesting, pest controlling, fertilizer application etc.



Picture 9. Use of GPS in precision farming cycle (Párrizas, 2011)

The GPS in tractor is programmed to operate in the specific route where the operation is needed to be accomplished. It can save time and fuel cost by used only in the targeted area. Similarly, insects and pests can be controlled with the help of GPS system. The insects and pests in the field do not occur in all the area at the same time. In this situation, the GPS system can be used to collect the data to show the location of severity of insects and pests. It is very useful for an operator to operate crop-duster only in the targeted area of the field.

Likewise, the large livestock farm can be managed with the help of GPS transmitter. Tracking of every animal is possible with using GPS transmitters. The GPS transmitter which is attached in the animal collar enables the identification of the location and the monitoring of animals one by one. The soil sampling is also a useful operation which can be performed with the help of GPS along with mapping software. This is very useful for identifying the location and area of soil that is needed to be treated or not. It helps to save fertilizers and minimize to exposure of chemicals to areas where it is not needed.

6 PRESENT SCENARIO OF ICT IN NEPAL

6.1 Internet and Telecommunication

There is no doubt that the Information and communication in Nepal is one of the most prioritized sectors in the last ten years which has been tremendously reaching more people year after year. The government of Nepal has made a great effort in this sector and makes it possible with making the decision to provide licenses for the private sector. Private sector licensing is one of the turning points of the development of information and telecommunication in Nepal. Along with this, the government of Nepal is planning to set up a learning center in every electoral district.

Table 1. ICT growth trend in Nepal (NTA, 2012 & BuddeComm, 2011)

Category	**2010**	**2011**	**2012**
Fix-line Services			
Total number of subscribers	841,700	845,000	851,317
Annual growth	4%	0.39%	0.74%
Penetration rate (polulation)	2.9%	2.9%	3.19%
Internet			
Total number of subscribers	142,200	180,000	4,867,254
Annual Growth	35%	26.76%	extreme growth
Subscriber penetration rate (population)	0.5%	0.6%	18.28%
Mobiles Phone Services			
Total number of subscribers	9.2 million	13.3 million	14.8 million
Annual growth	21%	45.56%	11.27%
Subscriber penetration rate	33%	46%	55.40%

The above table shows that the different aspects of fixed line phone, Internet and mobile phones over last three years. The total numbers of subscribers, the

annual growth rate and penetration rate are the three main aspects that have been listed in the table.

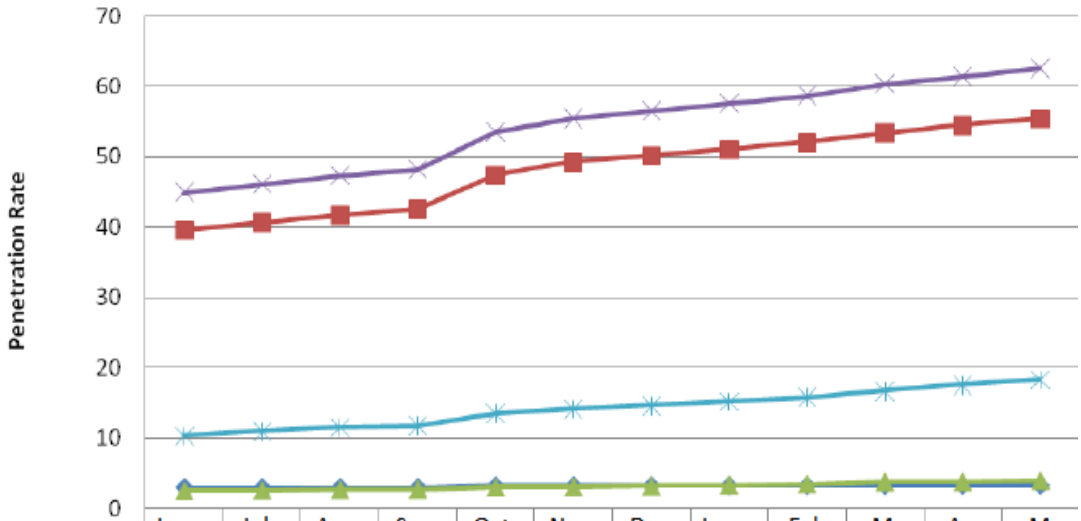
The fixed line phone subscribers have not increased so much in the last few years. The mobile phone service extension is the main reason why people prefer to have mobile phones instead of fixed line phones. The table shows that mobile phone users and internet users have significantly increased every year.

The fixed phone subscribers were 841,700 until 2010. The numbers had reached up to 845,000 and 851,317 in 2011 and 2012 respectively. Therefore this table shows that there is only 4%, 0.39% and 0.74% annual growth rate and 2.9%, 2.9% and 3.19% penetration rate of fixed line telephone in the year 2010, 2011 and 2012 respectively.

On the other hand, the internet users have increased dramatically over the last three years. The internet users in 2010 were approximately 142,200. However, the user numbers had been sky-rocketed up to 4,867,254. The main reason for this dramatic increment is the face that the mobile service providers had begun to provide GPRS in cell phones. There is also another reason; the private sector ISP begun their service and price of internet went down substantially as a whole. Obviously, internet penetration rate from 2010 to 2012 had been changed a lot.

Similarly, the mobile phone users have increased from 9.2 million to 14.8 million over last two years. The mobile service providers are extending their service to rural areas. There are three mobile phone service providers at the moment and the mobile phone service penetration rate has reached up to 55.40 % at the moment.

Since there are still more markets in ICT field, there are more service providers coming and expected to come in the near future. Therefore, the number of subscribers is also expected to increase in the coming year. This is certainly good news for a country as a whole because ICT is an important technology which can provide a lot of information for the development of any sector.



	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Fixed	2.93	2.93	2.94	2.94	3.16	3.17	3.17	3.18	3.18	3.19	3.20	3.19
Mobile	39.53	40.59	41.7	42.52	47.38	49.21	50.16	51.1	52.0	53.39	54.46	55.4
Other	2.43	2.52	2.63	2.68	2.96	3.03	3.13	3.28	3.46	3.75	3.76	3.95
Total	44.9	46.05	47.27	48.14	53.5	55.41	56.46	57.56	58.66	60.34	61.42	62.56
Data/Internet	10.28	10.89	11.46	11.72	13.49	14.09	14.55	15.2	15.75	16.67	17.53	18.28

Figure 1. Growth Trend of Voice Telephone and Data Service Penetration from June 2011 to May 2012 in Nepal (NTA, 2012)

6.2 Television broadcasters and Radio Frequencies

The first television service started in January 1985 in Nepal. The government started to run the channel “Nepal Television” with the slogan “Communication for Development”. This was the only one television channel in Nepal until 2002. Since then, the government of Nepal had started to give licenses to private channels. According to data provided by the Ministry of Information and Communication of Nepal (Sajha Sawal, 26 August 2012) on a TV program, there have been registered 475 FM radio and 39 Television channels but only 329 FM radio stations and 18 television channels are operational at the moment. Out of 329, more than 200 are licensed as community radio out of which 144 stations are operated as community radio (ACORAB, 2012). Community radios are non-profit making and usually owned by institutions and organizations. Moreover, the cable television channels providers are also broadcasting their own local channel as well as some international television channel. There are about 482 licensed cable TV operators all over the country

but only 365 operators are in operation at the moment (MOAF, 2011). There are more than 100 international channels available which include the popular channels such as BBC news, CNN, Al Jazeera, ESPN Sports, National Geographic, Animal planet and many others Indian channels as well. Recently, some companies have started offering direct satellite television to the customers.

Having considered that there are many ethnic groups in Nepal and they have their own languages, most of the television media and FM radio stations are broadcasting news and other programs in their languages during certain hours in every day. Now-a-days the television is the main source of information and news in urban areas. However, the radio frequencies are a still major source of news and information over all.

Most of the households in Nepal have their own television and radio set; however, the shortage of electricity limits the using hours of Television. Some part of country is still out of electricity but the government has continuously been working to extend electricity to every household in the near future. Therefore, the television viewers are increasing day by day.

7 METHODOLOGY

7.1 Research Approach and Procedure

Most of the findings in this thesis work are brought from the information and data provided by Government authorities as well as non-governmental organizations which are working in ICT for Agriculture in Nepal. Those data and information are referred from their official websites; therefore this is authentic information. The monthly report, annual report, current activities and events and country paper of respective governmental authorities as well as non-governmental organizations are the main source of the updated data and information.

First of all, the existence of Agriculture Information and Communication Center (AICC) in Nepal was acknowledged, since it is the main governmental authority to work on the Agricultural Information and Communication system in country. With the help of Google Search Engine, the contact information of AICC was found out. Then, more information about the other governmental and non-governmental organizations which are working on this field was acknowledged with the help of AICC personnel. Phone call, email and internet were the communication media which were used during this thesis writing process. Then, the up-to-date information and data were collected from their annual reports, country papers, monthly reports which are published on their individual websites.

7.2 Brief Introduction of Study Organizations

7.2.1 Agriculture Information and Communication Center (AICC)

AICC is one of the main departments under the Ministry of Agriculture and Cooperatives Nepal. This governmental department is responsible for dissemination of agricultural innovation to the lower branches as well as to the farmers through television, radio, print media, internet and mobile phone. At the moment, AICC is collaborating with Nepal Television channel, Radio Nepal,

Nepal Telecommunication Authority to disseminate agricultural information to the farmers.

7.2.2 Department of Hydrology and Meteorology (DHM)

DHM is one of the departments under the Ministry of Environment Nepal. This department is also partly working on Agricultural meteorology. This department has established 22 different Agro-meteorological stations all over the country. Those stations are established mainly with the collaboration of Agricultural Research Centers.

7.2.3 Center Bureau of Statistics (CBS) of Nepal

CBS is an agency under the National Planning Commission Secretariat of the Government of Nepal. It is responsible for collection, consolidation, processing, analysis, publication and dissemination of statistics, data and GIS Map. CBS also provides many agriculture-based GIS Map such as natural resource management, land use, soil type, etc.

7.2.4 Logged on Foundation

This is an Australia-based non-profit organization and was established recently in 2011. It also works as a charitable organization and working at some rural parts of Nepal at the moment. The main mission of this organization is to empower the rural disadvantaged people through information and communication technology

7.2.5 Practical Action Nepal

The Practical Action Nepal, an International Non-governmental Organization is one of the good examples, which is financially supported by United Kingdom's Department of International Development, European Union and others too. This organization is working in some rural villages on the area of Agriculture disaster management along with food security and climate change, market information about agriculture inputs and products and also responding to new technologies including ICT to the rural farmers. Practical Action is now working in 17 Districts in Nepal. Those districts are Dolpa, Jumla, Kalikot, Achham, Doti, Kailali,

Surkhet, Bardiaya, Banke, Gorkha, Rasuwa, Tanahun, Dhading, Nawalparasi, Chitwan, Rupandehi and Dang.

Picture 10. Working Regions of PAN (Practical Action, 2012)

7.2.6 International Center for Integrated Mountain Development (ICIMOD)

ICIMOD is a Hindu Kush Himalayan region based learning and knowledge exchanging center at intergovernmental level. This center has eight members from different Himalayan countries like Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. This organization is working for the mission of assisting the population of mountain region to adopt in the changing ecosystem of Himalayan regions. ICIMOD has also been working in collaboration with the government of different countries to develop a GIS database for different agriculture-related sectors. The Center has established their own division called Mountain Environment and Natural Resources' Information Service (MENRIS) for the development of application related to the GIS and Remote Sensing focusing mainly on mountain regions.

7.2.7 Nepal Wireless Networking Project

This project unofficially started in 2001 with the help of some International volunteers, Jonni Lehtiranta from Finland, Johan Verrept from Belgium and Robin Shields from USA. The main leading person of this project is Mahabir Pun who started to connect a remote village Nangi to other village Ramche through internet communication. The project is now running officially with the mission of providing internet to rural people transforming their socio-economic life. The official project name now is E-Networking Research and Development for facilitating rural areas of Nepal with ICT services. This project has now reached more than five districts of the country.

7.3 Constraints of Study

There were many difficulties encountered during this thesis writing processes. Some of them were very common whereas others were rather complicated too. However, the effortful and careful management of such scenario of limitation were made without hampering the outcome of the study.

In the beginning phase of the Thesis, there were some difficulties to get the response of email from where it was sent to find the information about those organizations involved in work for the agriculture sector through ICT. Therefore, direct phone calls were a better option after all to reach them quickly. Those phone calls were not enough for this study whatsoever. Nevertheless, some starting ideas were more than enough to go forward. With those clues, it took some time to find those valuable data and information with the help of internet search engine. Finally, the individual webpages of those organizations made it possible to get more up-to-date information.

During the data and information collection process, there were some language and date conversion barriers. Since the data and information were provided in the Nepalese language, the conversion and translation of those valuable data and information may have led misinterpretation or degeneration the main theme of the study. In the case of date conversion, there were some difficulties to represent the information and data to Gregorian calendar since, the information

were written in Nepali calendar format. At the end, the above mentioned restriction and limitation has no bearing whatsoever with the result of the study since it was done more carefully and sincerely in order to overcome them.

8 RESULTS AND FINDINGS

8.1 ICT in Nepalese Agriculture

ICT has always been a very important driving force in a country's economy. It has already showed its potential in the industrial world. However, it still has to be seen more in agriculture. Sometimes, it seems somehow complicated to understand the reason and idea about using ICT in agriculture. However, it is true that there are definitely some factors to be considered especially in a developing country such as Nepal. Nepalese economy is highly dependent on agriculture which accounts for more than 40 % of national GDP and 76% of the countries labor forces are engaged with it.

Agricultural practices have not achieved more effective technologies. Most of the farmers are still practicing the same procedures for centuries and have not achieved satisfactory harvesting. There are many reasons behind this. For example, there is lack of information about changing weather patterns, soil conditions and other factors such as the appearance of frequent pest and diseases. Therefore, there is a need for proper information and communication system to overcome these challenges. Thus ICT is very useful tool to improve work efficiency for the growth of agricultural production.

Agriculture Information and Communication (AICC) is a division under the Ministry of Agriculture and cooperatives of Nepal which are responsible for the dissemination of agricultural information to farmers' level using different media. Since the development of the ICT sector in last few decades, the traditional media has been gradually out casted. Therefore, the use of ICT such as internet, computer, digital camera, mobile phone, television and FM radio station etc. have posed a new challenge of how to manage an agricultural information system in the country.

8.1.1 Computer and Internet in Nepalese Agriculture

According to the country paper on National Agriculture Extension Services in Nepal, published in August 20011, AICC possesses about a dozen of computers with radio link broadband connectivity installed at the center. Moreover, AICC has also created its web portal “www.aicc.gov.np” in which general agricultural statistics of Nepal and introduction of organizations, departments, centers, boards and committees under the ministry are placed. Furthermore, an electronic journal and the bimonthly agriculture magazine “Kristi” has also been published on the website as a pdf file which can easily be downloaded and read. The National Agriculture Policy 2004, Agriculture Business Policy 2004, and a number of booklets on various aspects of agricultural technologies are also kept on the website. All these all electronic materials are written in Nepali font so that all Nepalese people who have got basic education can read them in their own language. The portal is also a gateway to all government ministries and relevant organizations as they are linked to the website. Some important websites linked to this URL are “www.moac.gov.np”, “www.nardf.org.np” and “www.narc nepal.org” which are the official websites of Ministry of Agriculture and Cooperatives (MOAC), Nepal Agriculture Research and Development Fond (NARDF) and National Agriculture Research Council (NARC) respectively. These all departments have their own publications related to agriculture are also available online.

The Directorate of Agriculture Extension Services is the main division of the government of Nepal is the responsible body for disseminating agricultural technology to farmer’s level through printed media. Since 2007, this Directorate has made its own website and most of its publications as well as the publication related to agriculture from district level have also been published on the website. Those publications are easily downloadable in pdf format. The Ministry of Agriculture and Cooperatives of Nepal has also URL links to different agriculture- related national and international Organizations.

In private level, an Australian charitable organization called “Logged on Foundation” is working in the Astam village near Pokhara, the second largest

city of Nepal. They have established a computer center and have also provided training to the local villagers. The agriculture of this village also benefits from the establishment of the computer center.

8.1.2 Use of Telephone and Mobile Phone

The directorate has also started the direct interaction program with farmers by telephone on every Monday from 10:00 AM to 11:00 AM. The hotline telephone number is 01-5523602. There is one of international non-governmental organization called Practical Action Nepal which is running some projects in different districts by providing information with mobile phone calls. Farmers get information about early disaster warnings related to agriculture, market price of agricultural inputs and outputs and other agricultural practices.

8.1.3 Agro-meteorological Station

Since agriculture is directly related to weather conditions, the weather prediction information management is an important factor in order to avoid any agricultural disaster in the country. Therefore, the Department of Hydrology and Meteorology (DHM) has established and timely upgraded 22 agro-meteorological stations all over the country. Most of the stations have computers with internet connection which are used to collect and analyze agro-meteorological data for future use. According to the Ministry of Environment, Science and Technology, DHM is equipped with several data collection facilities based on different technologies such as, wireless communication, meteor burst, radiosonde, Satellite Distribution Information System (SADIS), Weather Fax, and satellite picture receiving system. A wireless system connects Kathmandu to 54 stations spread over Nepal for climatic and hydrological data whereas the Global Telecommunication System (GTS) links DHM to the global meteorological community. Moreover, DHM is also equipped with GIS and Remote Sensing technology to observe spatial weather variation and data management for future use. However, not all stations have all kinds of the above mentioned facilities. Only few of them have those facilities whatsoever.

8.1.4 Mass Media (Radio & Television)

Radio Frequencies are the oldest mass information and communication technology established in 1951 in Nepal. Having considered this technology, it is a very effective way of mass communication; AICC has begun to reach the farmers with useful agricultural information and technology through a government-run radio service called “Radio Nepal” since December 10, 1966. According to a report prepared by the Ministry of Agriculture and Cooperatives in 2011, there are about 3 million radio sets with Nepalese families and 83 percent of the total population of Nepal can receive the services of Radio Nepal. Therefore, AICC have made some effort by broadcasting the agricultural program from 6:40 PM to 6:55 PM daily.

Table 2. Radio Program Activity (MOAC Nepal, 2012)

Days	**Programs (6.40 PM - 6.55 PM)**
Sunday	Agricultural news
Monday	Farmers’ questions and expert’s answers
Tuesday	Food Nutrition, Cooperatives etc.
Wednesday	Interview with farmers and specialists
Thursday	Livestock farming radio magazine
Friday	Dialogue between Junior Technical Assistant (JTA) and old women
Saturday	Commercial Agriculture

Moreover, there is not only one radio station these days. Radio Nepal has already started five regional broadcast stations in country. Those regional stations are also running agricultural program focusing on the farmers of those regions. After the decision made by the government to give license to private sector, there are growing numbers of FM stations in many part of the country. Now-a-days, there is at least one FM station in the headquarters of most of the districts. Some economic centers and historical places also have FM stations. The FM stations in the region where most of the people are engaging in agriculture are also broadcasting many agriculture-related programs. Farmers are benefiting by getting first-hand information such as market price of

agricultural input and agricultural products. They are also benefited by getting solutions of different agricultural practices such as insect and pest control, plant disease, fertilizer application techniques. Farmers also get information about important agricultural events, such as farmers' training, agricultural competitions and exhibitions etc.

The concept of community radio has become more popular in the recent years in Nepal. These radios are usually run by local community or institutions or organization and focusing on local interest, background, language, ethic and traditions. These radios have helped to promote agriculture by providing useful agricultural information. The stations are running in all districts of the country and have covered the interest of marginalized population and ultimately helped to improve the socio-economic status of those communities.

Nepal Television (NTV) and its metro channel are the only two government-run Television channels in the country. "Nepal Television (NTV), which started its service in 1984, has 3 studios and 15 broadcasting centers telecasting to about 50 percent of land coverage and 65 percent of population coverage in Nepal. AICC has been telecasting 15-minutes programs since 1996 from NTV daily at evening time. From mid-July 2006, the telecasting duration has been extended to 20 minutes" (AICC, 2011).

Table 3. Television Program Activities (MOAC Nepal, 2012)

Days	**Programs**
Sunday	Discussion on Agricultural Issues
Monday	Success Story
Tuesday	Farmers' Problems and Technicians' Reply
Wednesday	Agricultural Technology
Thursday	Agriculture in Foreign Country/ Farmers' Useful Technology
Friday	Agricultural Activities
Saturday	Agricultural Tele Serial (TV Show)

Similarly, there are few private and community television channels which are also planning to include Agriculture Awareness programs. Youth Awareness Environmental Forum / Environment Information Center are going to launch a community television channel called ETV.

The short agricultural program on radio and TV is a good initiation but the duration of program is not long enough. In some remote areas, farmers cannot receive radio and television signals. Therefore, they are ignorant of new information and they practice what they have been doing for decades or centuries. These kind of traditional practices do not help to improve agricultural productivity.

8.1.5 Geographical Information System (GIS)

Since the GIS technology is a very useful technology, Central Bureau of Statistics of the Government of Nepal has provided GIS maps for different subjects of agriculture. Those subjects are listed below.

- Average Agricultural Holding Size
- Distribution of Agriculture Holding Area by Type of Soil
- Distribution of Fruit Trees
- Holdings having Agricultural Credit
- Distribution of Agricultural Holdings
- Distribution of Area Holdings with Agricultural Land
- Distribution of Livestock
- Agriculture Holdings by Sufficiency of Agriculture

The International Center for Integrated Mountain Development (ICIMOD) is an active organization that has established a GIS database for many sectors including agriculture through its department called Mountain Environment and Natural Resources' Information Service (MENRIS). ICIMOD is collaborating with the Government of Nepal and the Government of Germany. They have developed a geo-portal application for core GIS data of land use and land cover, ecosystem and biodiversity, climate and hydrology, disaster and natural

hazards and socio-economy and livelihood of Nepal. All these categories are closely related to agriculture.

8.2 Summary of the Results

This study shows that the government of Nepal has already established the Information Communication Technology in Agriculture such as information dissemination through internet, mass media (Television, Radio), Telecommunication (mobile phone, fixed line phone), agro-meteorological stations with using computerized instruments, Geographical Information System and Remote Sensing. However, the results also show that those technologies are not sufficient from a quantitative as well as qualitative point of view. For instance, the question is how effective is the agriculture program broadcasted by Nepal Television channel and Radio Nepal with a duration of 20 minutes and 15 minutes respectively every day. However, the growing private FM radio station and television channels have covered this insufficiency of time for agricultural programs. Those private FM radio and television are broadcasting more effective programs focusing on local communities and using local languages.

Many governmental and non-governmental organizations have started to publish monthly agricultural magazine also on their individual websites, which are written in the Nepali language. Farmers heavily benefit from those magazines.

In the case of internet and mobile phone, the users in the country have increased tremendously in last few years, which is very positive for the dissemination of agricultural information and technology. There are not only the governmental organizations but also private organizations that are heavily involved for extending ICT infrastructures in different parts of the country. In this scenario, there is only one national hotline telephone service established at government level. Although it is good to start services, the duration and frequencies of time are not sufficient for farmers to get telephone line as 76% of the people are engaged with agricultural activities in the country.

The government has also made available a GIS map related to different agricultural prospective for everybody with the collaboration of non-government organizations such as ICIMOD. GIS maps are really helpful to establish and manage good agricultural enterprises.

9 RECOMMENDATION AND CONCLUSION

During the past few decades, there have been tremendous developments in the information and communication technology sector in Nepal. Many private companies have been investing a huge amount of money in this sector and government cooperation has also paid attention to establishing and cooperating with foreign investors. The Computer Association of Nepal (CAN) is a leading organization to lead the country's ICT sector with the motto “Placing Nepal on the Global IT Map”. The possibilities of reaching international level is predictable because the world’s two powerful nations in ICT, China and India are the neighboring countries which are highly positive for their neighboring country, Nepal; therefore, collaboration in this field is very essential to exploit their information and communication technology to open the door to stand in international level.

In the last few decades, E-commerce had been playing a great role in the world's economy. In developing countries, both the public and private sectors have given priority to gathering all pre-requisites for the establishment of reliable and accessible E-commerce. “Electronic Business has gradually received significant improvement in developing countries in recent years but there is still existing some differentiation” (UNCTAD, 2003). There are many difficulties to implement ICT in the developing world. Both government and private sectors are aiming to overcome those barriers. However, those attempts are not still sufficient to increase economic production. Therefore, the improvement of E-commerce, E- agriculture and ICT-supported tourism could make positive difference in economic development.

“There are five main trends that have been the key drivers of the use of ICT in agriculture, particularly for poor procedures:(1) low-cost and pervasive connectivity, (2) adaptable and more affordable tools, (3) advances in data storage and exchange, (4) innovative business models and partnerships, and (5) the democratization of information, including the open access movement

and social media. These drivers are expected to continue shaping the prospects for using ICT effectively in developing-country agriculture" (World Bank, 2012).

There are several phases in agricultural practices where the ICT system is inevitable for advanced and highly productive agriculture. Digital technology is a key factor in this age of computer technology and its management, development and implementation should be properly understood by ICT technicians. Furthermore, agricultural activities such as research and development, fieldwork, documentation are the most important agenda to be connected in software application development, digitalized information data, computerized tool for agricultural practices etc.

The amounts of evidence of uses of ICT in global agriculture are enormous. Nevertheless, Nepal has not been able to exploit Information Communication Technology in agriculture which already exists and is possible to use. From this point of view, there are still many ICT technologies that should be implemented.

The geographical condition of Nepal is the main obstacle for the development and extension of ICT sector. There is no proper motor road to access in the hilly and mountainous region which hampers transporting tools and materials needed for ICT such as electricity poles, cables, etc. Examining this situation, the collaboration with different authority such as the transportation ministry is necessary in order to develop infrastructure so that it could make easy to carry the materials across the hilly region.

Computer and Internet are still inaccessible to most of the farmers. The establishment of computer and internet center in every village is the best way to close the gap between rural community and ICT. Along with this, the proper ICT training of the farmers is needed since most of the farmers in rural area are illiterate about ICT.

The low income group of people cannot pay expensive phone and electricity bills. This is the major challenge in Nepal where the majority of people have under low income status. The people who are using electricity, phone and

internet at home, are unable to pay maintenance and management costs. Therefore, government subsidies are necessary to make ICT accessible in the field.

There is lack of timely needed cyber law and regulations which make it very difficult to establish new technology in the country. The main cause of this problem is the weak governance and relevant authority. Therefore, a proper cyber law in the country should be implemented as soon as possible to regulate ICT.

The study of behavioral changes of farmers with the establishment of ICT might be further potential research topic to study real future scope in-depth.

Finally, collaboration is very important factor to accelerate the process toward achieving goal of ICT for agriculture. Therefore, it seems that there is no proper collaboration among Internet service providers, software developers, agriculture authority, electricity authority, telecommunication authority, education authority and so on. Therefore, the collaboration is needed (1) to disseminate agriculture information and technology (2) to develop user friendly application such as Nepali language software (3) to establish hotline telephone service to solve the farmers' problem with the help of phone calls (4) to establish community computer and internet center for farmers (5) to introduce new ICT in agriculture with the study of ICT use in other developed and developing countries.

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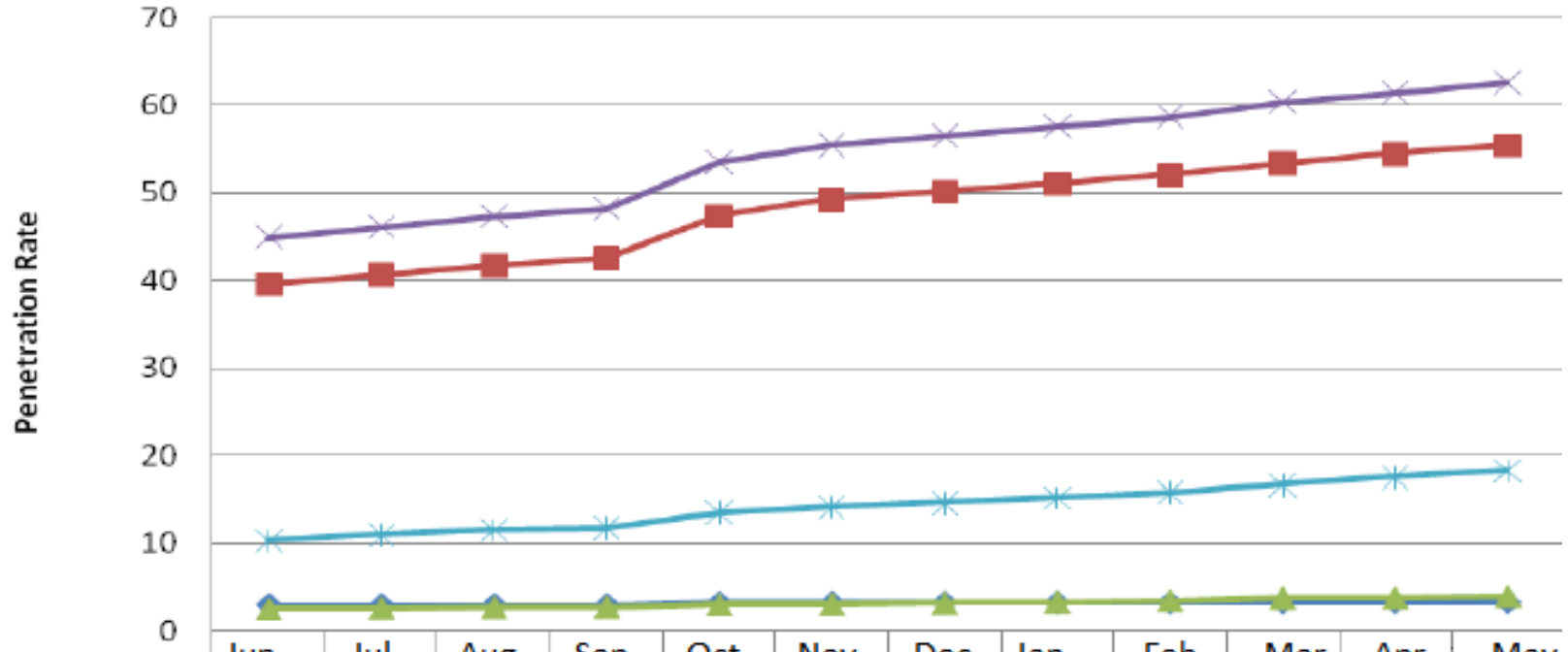
APPENDICES

Appendix 1: License issued by NTA until May 14, 2012 (NTA, 2012)

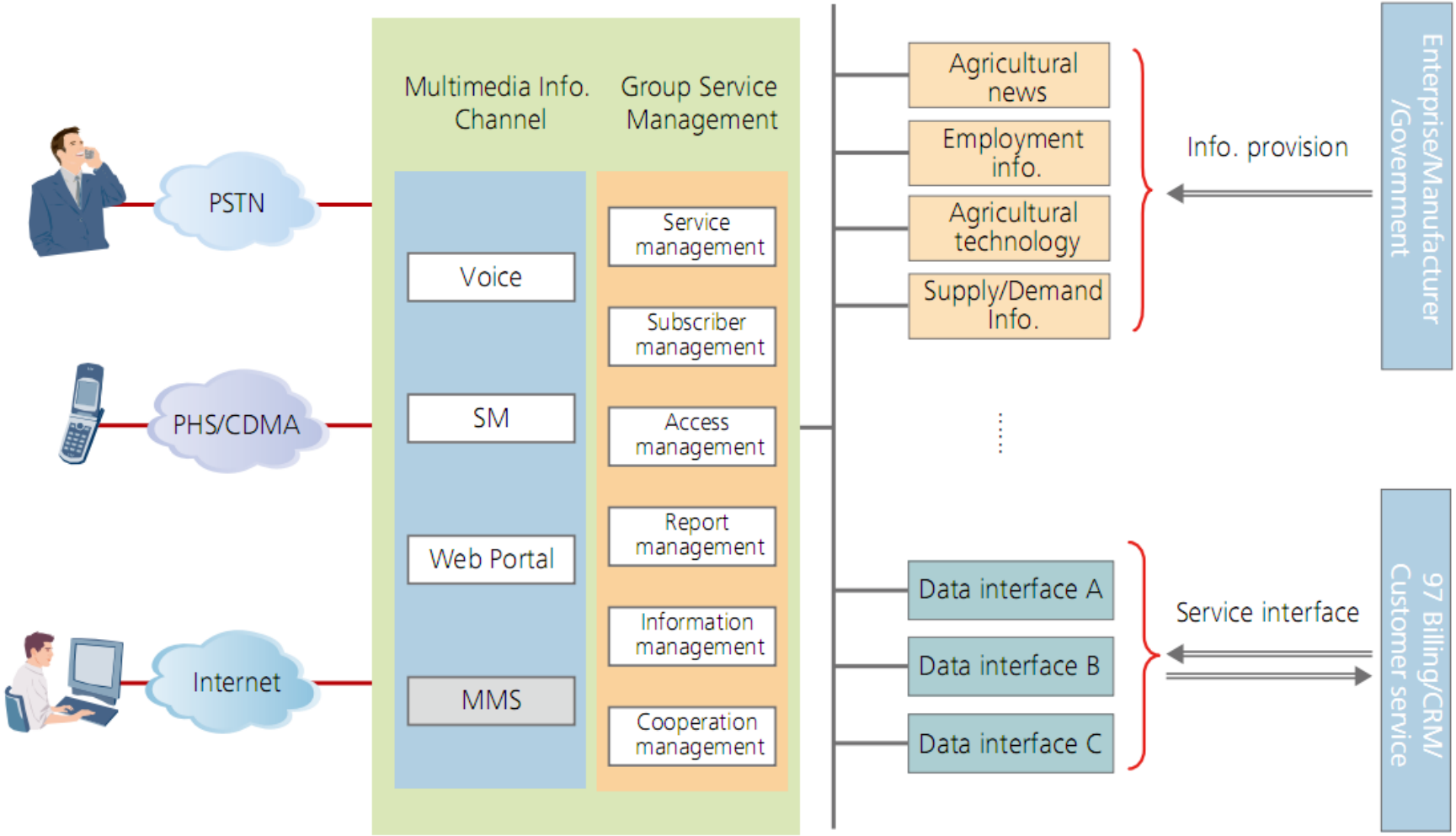
S. N.	Name of the services	Number of the Licensee
1	Basic Telecommunications	3
2	Cellular Mobile	3
3	Network Service Providers	7
4	VSAT User	74
5	Internet(with email)	43
6	GMPCS	3
7	Rural Telecom	2
8	Limited Mobility	108
9	Rural VSAT Users	13
10	Rural Internet Service Provider	6
	Total	**265**

Appendix 2: Growth Trend of Voice Telephone & Data Service Penetration (NTA, 2012)



	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Fixed	2.93	2.93	2.94	2.94	3.16	3.17	3.17	3.18	3.18	3.19	3.20	3.19
Mobile	39.53	40.59	41.7	42.52	47.38	49.21	50.16	51.1	52.0	53.39	54.46	55.4
Other	2.43	2.52	2.63	2.68	2.96	3.03	3.13	3.28	3.46	3.75	3.76	3.95
Total	44.9	46.05	47.27	48.14	53.5	55.41	56.46	57.56	58.66	60.34	61.42	62.56
Data/Internet	10.28	10.89	11.46	11.72	13.49	14.09	14.55	15.2	15.75	16.67	17.53	18.28

Appendix 3: Platform Architecture of E-Agriculture in China (Huawei Technologies, 2009)



Appendix 4: Agro- meteorological Stations in Nepal (DHM, 2012)

Station name	Index No.	District	Latitude	Longitude	Elevation	Estd. date	
			deg.min.	deg.min.	meter	Month	Year
BHAIRHAWA (AGRIC)	707	Rupandehi	2732	8328	120	JAN	1968
BHOJPUR	1324	Bhojpur	2711	8703	1595	JUN	1954
CHIALSA	1220	solukhumbu	2729	8637	2770	MAY	1966
DUMKAULI	706	Nawalparasi	2741	8413	154	OCT	1965
GAIDA (KANKAI)	1421	Jhapa	2635	8754	143	FEB	1984
GORKHA	809	Gorkha	2800	8437	1097	JUN	1956
ILAM TEA ESTATE	1407	Ilam	2655	8754	1300	MAR	1956
JIRI	1103	Dolkha	2738	8614	2003	AUG	1961
KAKANI	1007	Nuwakot	2748	8515	2064	JAN	1962
KHAIRINI TAR	815	Tanahun	2802	8406	500	MAR	1969
KHAJURA (NEPALGANJ)	409	Banke	2806	8134	190	JAN	1968
KHUMALTAR	1029	Lalitpur	2740	8520	1350	MAY	1967
LAHAN	1215	Siraha	2644	8626	138	NOV	1955
LUMLE	814	Kaski	2818	8348	1740	NOV	1969
MALEPATAN (POKHARA)	811	Kaski	2807	8407	856	APR	1966
MANENDRA NAGAR	105	Kanchanpur	2902	8013	176	FEB	1971
PAKHRIBAS	1304	Dhankuta	2703	8717	1680	JAN	1976
PARWANIPUR	911	Bara	2704	8458	115	JAN	1967
RAMPUR	902	Chitawan	2737	8425	256	JAN	1967
SIKTA	419	Banke	2802	8147	195	MAY	1978
TARAHARA	1320	Sunsari	2642	8716	200	JUL	1968
THAKMARPHA	604	Mustang	2845	8342	2566	DEC	1966